Request For Information

In the Office Action, the Examiner has a request for information under 37 C.F.R. 1.105 with regard to "particular experimental data showing that the lower limit and upper limit in the range as claimed for oxygen, nitrogen and hydrogen concentrations have been reduced to practice."

Applicants believe that the following explanation with regard to the claimed concentrations of from 55 to 70 atomic%, from 0.1 to 6 atomic%, and from 0.1 to 3 atomic%, of oxygen, nitrogen, and hydrogen, respectively, in the present invention will satisfy the Examiner's request.

The hydrogenated silicon oxynitride film of the present invention is manufactured by plasma CVD with SiH_4, N_2O, and H_2 as raw material gases. In order to accomplish such concentrations of oxygen, nitrogen and hydrogen, the substrate temperature is set from 350 to 500°C, preferably between 400 and 450°C, and the electric discharge power density is set between 0.1 and 1 W/cm^2. See e.g. the last paragraph on page 4 of the specification of the present application.

By adding hydrogen to the conventionally used SiH_4 and N_2O gas mixture when manufacturing the hydrogenated silicon oxynitride film by plasma CVD, radicals created from the decomposition of SiH_4 are prevented from being polymerized in the gas phase (within the reaction space), to thereby eliminate the creation of particles. See e.g. the first paragraph on page 5 of the specification.

If H_2 is not included as a raw material gas as in Yamazaki (JP 08-55847 or US 5,970,384), particles are created as follows:

In the reaction space, the majority of SiH_4 is undecomposed, and the minority of SiH4 is decomposed, and thereby radicals such as SiH_2 are created. With respect to the other raw material gases, majorities of them are undecomposed, and minorities of them are decomposed, and thereby

radicals are created. When the below reaction is repeated, particles such as SiH_4 (radical), Si_3H_6 (radical), and so on, are created.

However, if H_2 is included as a raw material gas, as in the present invention, H_2 prevents SiH_2 (radical) from reacting with SiH_4 (undecomposed), and thereby the creation of the particles is prevented.

$$SiH_2 \text{ (radical)} + SiH_4 \text{ (undecomposed)} \rightarrow Si_2H_4 \text{ (radical)} + H_2$$

$$+$$

$$SiH_4 \text{ (undecomposed)} \rightarrow Si_3H_6 \text{ (radical)} + H_2$$

$$+$$

$$SiH_4 \text{ (undecomposed)} \rightarrow \ldots$$

Further, according to the first paragraph of page 5 of the specification, in the film growth surface, excess hydrogen can be prevented from being taken into the film by an abstraction reaction of surface adsorbed hydrogen by hydrogen radicals. This kind of action has a close correlation with the substrate temperature during film deposition and cannot be obtained unless the substrate temperature is set to the range of the present invention. As a result, it is possible to form a dense film with a small defect density, and the trace amount of hydrogen contained within the film works effectively in relieving lattice warping. In order to decompose the water and increase the concentration of hydrogen radicals developed, it is appropriate to set the frequency of the high frequency power supply for generating the glow discharge to between 13.56 MHz and 120 MHz, preferably from 27 to 70 MHz.

Therefore, as explained above and as taught in the specification, the claimed concentrations are advantageous and beneficial.

Yamazaki and Wörhoff (cited in the request comments) appear unrelated to the claimed concentrations, advantages and reasons for these concentrations. For example, neither Yamazaki nor Wörhoff recognize the above effects of adding hydrogen to the conventionally used SiH_4 and N_2O gas mixture when manufacturing the claimed hydrogenated silicon oxynitride film by plasma CVD. Yamazaki discloses using TEOS and oxygen (see e.g. col. 5, lines 53-54), or SiH_4, N_2O, NO or NO_2 (see e.g. col. 13, lines 15-19) as raw material a CVD method. Yamazaki does not disclose using hydrogen as a raw material gas. Wörhoff discloses using N_2O, NH_3 and SiH_4 or N_2 as a raw material gas but also does not disclose using hydrogen as a raw material gas. As these references do not disclose the claimed concentrations, there is no need for experimental data of these claimed concentrations.

Furthermore, Wörhoff appears to be interested in that a silicon oxynitride grown by CVD method is a material which is well-suited for the realization of high contract waveguides, since the range over which the refractive index of this material can be tuned (1.46-2) is large. In contrast, the present invention is directed to using a hydrogenated silicon oxynitride as a base film, a gate insulating film, and an interlayer insulating film so that the resulting semiconductor device has no shift in V_{th} and is stable with respect to BTS

Accordingly, it is believed that this explanation is sufficient, and in accordance with the disclosure in the specification, clearly supports the advantages and benefits of the claimed concentrations. Further, as explained herein, these concentrations are not disclosed or suggested by the cited references. Therefore, there is no need to show experimental data on such ranges.

Hence, it is respectfully requested that the Examiner withdraw the request for experimental data.

Claim Rejections - 35 USC §103

The Examiner has the following rejections under 35 U.S.C. §103:

1. Claims 41, 44, 45, 48, 51, 54, 57-61 and 67-69 are rejected as being unpatentable over Miyazaki et al. (U.S. 5,804,878) in view of Yamazaki et al. (JP 408055847 for which U.S. 5,970,384 serves as a translation) and Wörhoff et al. IEEE catalog 0-7803-4947 (04-1998).

2. Claims 42, 46 and 49 are rejected as being unpatentable over Miyazaki et al, Yamazaki et al, and Wörhoff and further in view of Sharp KK (JP 11101974).

3. Claims 43, 47 and 50 are rejected as being unpatentable over Miyazaki et al., Yamazaki et al. and Wörhoff and further in view Tang et al. (U.S. 5,684,365).

4. Claims 62-64 are rejected as being unpatentable over Miyazaki et al., Yamazaki et al. and Wörhoff and further in view of Yamazaki et al. (U.S. 5,784,073).

Each of these rejections is respectfully traversed.

As explained above, neither Yamazaki nor Wörhoff disclose or suggest the claimed concentrations. The other cited references (e.g. Miyazaki, Sharp, Tang, Yamazaki '073) also do not disclose or suggest this claimed feature.

Therefore, as the cited references do not disclose or suggest the claimed invention, the claims are patentable thereover. Accordingly, it is respectfully requested that these rejections be withdrawn.

Conclusion

It is respectfully submitted that the present application is in a condition for allowance and should be allowed.

Please charge our Deposit Account No. 50-1039 for any further fee due for this amendment or extension of time.

Favorable reconsideration is earnestly solicited.

Respectfully submitted,

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